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(54) Title: OAT-BASED FROZEN CONFECTION (57) Abstract A non-dairy frozen confection formed from a frozen syrup product, the syrup product having a major amount of an oat flour. The non-dairy frozen confection exhibiting selected sweetness, texture, and mouthfeel characteristics while being devoid of exogenous sweeteners, stabilizers, emulsifiers, and proteins.		

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OAT-BASED FROZEN CONFECTION

BACKGROUND OF THE INVENTION

The present invention relates generally to frozen confections. More particularly, the present invention relates to an oat-based, non-dairy frozen
5 confection.

Consumers are increasingly concerned about purchasing and consuming products that the consumers view as being more healthful. For example, products possessing higher levels of complex carbohydrates and fiber are becoming more popular with consumers. In addition, products containing
10 lower levels of fat and cholesterol as well as a decreased caloric content are becoming more popular with consumers. There is also a greater awareness to create products for consumers who need to exclude dairy products from their diets due to allergies.

A variety of non-dairy compositions possessing the above
15 characteristics have been developed. An article by Janet Raloff (*Beyond Oat Bran*, Food Technology 1991 (8), at 62) describes the physiological benefits of consuming an oat-based product, which is identified by the name Oatrim. The oat-based product is formulated from either oat bran or oat flour. The article indicates that the odorless and nearly tasteless oat-based product is particularly
20 suited as a fat replacement in low-temperature applications, such as frozen confections.

The oat-based product is described in further detail in Inglett, U.S. Patent Nos. 4,996,063 and 5,082,673. A mixture of oats and water is gelatinized by passage through a steam injection cooker at a temperature of between 138°C
25 and 143°C. After the pH of the mixture is adjusted, alpha-amylase enzymes are added to hydrolyze the starch in the mixture. Once hydrolyzation is complete, soluble fiber is separated from the mixture. Finally, the soluble fiber is dehydrated to provide the oat-based product. Examples in the Inglett patents

indicate that the oat-based product is mixed with additional components, such as milk and sugar, to formulate the frozen confection.

Mitchell et al., U.S. Patent No. 4,744,992, discloses using a dual enzyme method, which includes liquefying and saccharifying rice, to produce a high glucose syrup. Examples in the Mitchell et al. patent indicate that when the syrup is incorporated into a frozen confection, vegetable oil in a concentration of approximately 10 percent by weight of the frozen confection as well as stabilizers are added to provide the frozen confection with a creamy texture.

Murtaugh et al., U.S. Patent No 4,908,223, discloses an oat- or rice-based frozen confection and a method of preparing the frozen confection. Murtaugh et al. describes cooking an aqueous mixture of oats or rice. After the cooking is complete, liquefying, sweetening, and flavoring agents are added to the mixture so that the frozen confection exhibits ice cream-like characteristics.

Several fruit-based frozen confections have also been developed. For example, Feldpausch, U.S. Patent No. 4,948,614, describes using bananas to produce a non-dairy confection. Blake et al., U.S. Patent No. 4,335,155, discloses that any fruit, which can be made into a puree, is suitable for use as a base of a frozen confection. Blake, U.S. Patent No. 4,244,981, describes using citrus juice vesicles as the primary component of a frozen confection.

SUMMARY OF THE INVENTION

The present invention includes a non-dairy frozen confection. The non-dairy frozen confection is formed from a syrup that is frozen using conventional techniques. The syrup is produced by liquefying and saccharifying a starch source, which is primarily oat flour or waxy barley hybrid flour. The non-dairy frozen confection exhibits ice cream-like characteristics without exogenous sweeteners, stabilizers, emulsifiers, or proteins.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention includes a frozen confection. The frozen confection is made from a sweet, bland, and clean tasting syrup product. The syrup product is substantially prepared from oat flour or waxy barley hybrid flour.

The frozen confection of the present invention has several advantages over prior art frozen confections. The frozen confection exhibits desirable sweetness, texture, and mouthfeel characteristics without exogenous sweeteners, stabilizers, emulsifiers, or proteins, which are commonly used in prior art non-dairy frozen confections. As used herein, the term "mouthfeel" refers to a creamy sensation that a person experiences in one's mouth upon consuming ice cream. As used herein, the term "exogenous" refers to components that are added to prior art frozen confections to supplement or modify the characteristics of the prior art frozen confections.

Furthermore, when producing the frozen confection of the present invention, the syrup product does not require emulsification or homogenization. The prior art non-dairy frozen confections typically require emulsification and homogenization to produce characteristics that are commonly associated with dairy-based frozen confections.

The properties of the frozen confection are dictated by the particular oat or grain components selected. It has been found that using a low bran flour, which is depleted in bran while retaining soluble fiber glucans, provides a frozen confection with desired characteristics. The typical compositional analysis of low bran oat flour is similar to whole oat flour for moisture, protein, and fat, as illustrated in Table I. However, low bran oat flour contains a lower level of bran than whole oat flour. Low bran oat flour also retains a substantial percentage of the soluble fiber that is present in whole oat flour.

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Table 1

	Composition (weight percent)	Whole Oat Flour	Low Bran Oat Flour	Patent Oat Flour
5	Moisture	11	11	10
	Protein	18	15	11
	Fat	7	7	5-6
	Total Dietary Fiber	9	10	3-4
10	Beta-Glucan	4	7	1-2

While it is also possible to use oats or grains having a significant hull, bran, or husk portion to formulate the syrup, syrup formed from these materials must be separated from insoluble branny particles present in the syrup before the frozen confection is produced from the syrup. As an alternative to using the oats in the form of flour, it is also possible to practice the present invention with other forms of oats, such as rolled oats, partially milled oats, and oatmeal. These various forms of oats are collectively identified as "oat material".

One particular oat flour possessing a low level of bran or hull material is patent oat flour. Patent oat flour is a fraction of the whole oat flour obtained from a mill stream early in the oat milling process. The patent oat flour contains a smaller concentration of the bran or hull material than oat flour stream occurring later or downstream in the milling process. This oat flour is referred to as patent oat flour because it has similar characteristics to patent wheat flour that is produced by a process commonly used in the production of wheat flour for bread or other baked products.

The typical compositional analysis of patent oat flour is similar to whole oat flour for moisture, protein, and fat, as illustrated in Table 1. Patent oat flour also retains a substantial percentage of the soluble fiber that is present

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in whole oat flour. However, patent oat flour contains less bran or insoluble fiber and more starch than whole oat flour.

The various fractions formed in the oat milling stream produce frozen products with varied characteristics. The fractions high in soluble fiber, including whole oat flour and oatmeal, tend to give very smooth and somewhat "dry" texture to soft-serve frozen dessert, while those higher in starch content (e.g., patent oat flour) tend to provide more sweetness. It will be obvious to those skilled in the art that a desired set of finished product characteristics may be obtained by selecting an appropriate oat starting material or blend of available oat milling fractions. For example, the frozen confection may be formed from a mixture of patent oat flour and whole oat flour. Oat mill products possessing these characteristics can be obtained from various sources including Conagra, Inc (Council Bluffs, Iowa) or Grain Millers (Minneapolis, Minnesota).

It has also been found that a waxy barley hybrid flour also provides desirable results when used with the present invention. The waxy barley hybrid is a hull-less barley that is preferably selected from the prowashneupana variety, which can be obtained from Conagra, Inc. (Council Bluff, Iowa). The typical compositional analysis for the prowashneupana waxy barley hybrid is set forth in Table 2.

Table 2

Composition (weight percent)	Waxy Barley Hybrid Flour
Moisture	14
Protein	20
Fat	7
Total Dietary Fiber	29
Beta-Glucan	14

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Other starch sources can be used in conjunction with the oat flour or waxy barley hybrid flour to adjust the flavor and sweetness of the frozen confection. While other starch sources may be used in the preparation of the frozen confection, the other starch sources only represent a minor portion of oat
5 or grain material that is used to prepare the frozen confection. The oat flour and waxy barley hybrid flour comprise a major portion of the oat or grain material that is used to prepare the frozen confection.

Examples of starch sources that are suitable for use in the present invention include flours, such as corn flour, wheat flour, rice flour, and potato
10 flour. It is believed that the addition of other starch sources to the oat flour or waxy barley hybrid flour does not affect the functional properties of the frozen confection, such as texture and mouthfeel characteristics, associated with ice cream-like qualities.

As a preliminary step in the preparation of the frozen confection,
15 the oat flour or waxy barley hybrid flour is preferably milled to a fine granulation. The term "fine granulation" means less than 10 percent of the oat flour or waxy barley hybrid flour was retained on a 200 U.S. mesh screen. It has been found that a oat flour or waxy barley hybrid flour possessing this granulation produces a non-dairy frozen confection with a smooth texture.

20 A base formulation is created by blending the selected starch sources. A slurry is formed by mixing the base formulation into water in an amount that is effective to provide a solids level of between 25 and 33 percent on a dry matter basis. The water is preferably potable tap water that is provided at a traditional faucet temperature of about 10°C.

25 Changing the solids level allows the sweetness of the non-dairy frozen confection to be adjusted. For example, increasing the solids level causes an increase in the sweetness of the non-dairy frozen confection.

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Alpha-amylase enzymes are then added to the slurry. The alpha-amylase enzymes are preferably alpha-1,4-glucan, 4-glucanohydrolase, which is derived from *Bacillus subtilis*. The alpha-amylase enzymes not only produce liquefaction in a random fashion over a broad range of temperatures
5 (65°C to 92°C) but also retain its activity when used at temperatures of less than 80°C.

The alpha-amylase enzymes are preferably food grade alpha-amylase enzymes, which can be obtained from Genencor International (Rochester, New York) under the designation MULTIFECT H-39C. The
10 MULTIFECT H-39C enzymes are added to the slurry in a concentration of between 0.0020 and 0.0080 percent by weight of the slurry and preferably in a concentration of approximately 0.0040 percent by weight of the slurry.

Converting the starch mixture into the syrup product is preferably accomplished using a two-step process. The first step, which is referred to as
15 liquefaction, involves converting the slurry into an intermediate syrup. Liquefaction includes two elements. In the first element, microscopic starch granules in the starch mixture swell and eventually rupture. Rupturing of the microscopic starch granules causes the viscosity of the slurry to significantly increase. Once the viscosity of the slurry significantly increases, the starch is
20 referred to as being gelatinized. Gelatinization renders the starch more susceptible to partial hydrolysis.

In the second element, the alpha-amylase enzymes cause the starch to partially hydrolyze into dextrin. In conjunction with the partial hydrolysis of the starch, the viscosity of the slurry is reduced. It has been found that
25 performing liquefaction at a temperature of less than 75°C minimizes the off-flavors that are present in the slurry when liquefaction is performed at a temperature of greater than 75°C.

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The slurry is heated to a temperature of approximately 58°C to 60°C at which the viscosity of the slurry visibly increases. As an alternative to visually observing the increase in the slurry viscosity, the viscosity increase in the slurry may be determined by monitoring the amperage requirement of the mixing motor.

After the viscosity of the slurry increases, the rate at which the slurry is heated is decreased to allow the slurry to uniformly gel. The decreased heating rate also avoids scorching the slurry, which results from the rapid decrease in heat transfer caused by the increase in the viscosity of the slurry. Once the slurry reaches a target temperature of approximately 75°C, the slurry is maintained at the target temperature for approximately 1 hour.

The hold time allows the alpha-amylase enzymes to liquify the starch as the starch gels by converting the starch into dextrin. The conversion of starch into dextrin causes the slurry to change into an intermediate syrup. As the slurry is converted into the intermediate syrup, the raw flavor of the slurry is reduced. The reduction of off-flavors in the intermediate syrup can be monitored by tasting samples of the intermediate syrup at selected intervals while the slurry is held at the target temperature.

The intermediate syrup is then hot filtered to remove portions of the slurry that have not been broken down during the liquefaction process. Conventional screens or filters having a U.S. mesh size of 30 or smaller are suitable for use with the present invention. The filtered intermediate syrup is then cooled to a saccharification temperature of between approximately 60°C and 65°C.

In the second step, which is referred to as saccharification, the dextrin in the filtered intermediate syrup is converted into glucose. The conversion of dextrin into glucose causes the syrup product to exhibit a high degree of sweetness.

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The dextrin is preferably converted into glucose using glucoamylase enzymes. The glucoamylase enzymes are also referred to as fungal 1,4-alpha-D-glucan glucohydrolase, which can be obtained from Genencor International (Rochester, New York) under the designation SPEZYME GA 300.

5 The concentration of the glucoamylase enzymes is selected based upon the desired length of the saccharification time. For example, it has been found that using a glucoamylase enzyme concentration of between 0.090 and 0.130 percent by weight of the filtered intermediate syrup provides a
10 saccharification time of between 1 and 3 hours. Alternatively, using a glucoamylase enzyme concentration of approximately 0.016 percent by weight of the filtered intermediate syrup with a saccharification time of up to 24 hours provides a syrup product with similar properties.

 An advantage of using glucoamylase enzymes in the process of the present invention is that the pH of the filtered intermediate syrup does not have
15 to be adjusted to obtain a desired enzyme activity.

 At a given concentration of glucoamylase enzymes, the sweetness of the syrup product can be changed by varying the saccharification time. For example, increasing the saccharification time increases the sweetness of the syrup product.

20 After the syrup product obtains a desired degree of sweetness, the syrup product is cooled to a temperature of approximately 10°C. Because of the combined effect of low temperature used for the starch conversion, the absence of salt, and the low bran (insoluble fiber) content of the patent oat flour, the syrup product is clean and bland with no off-flavors.

25 The syrup product may be then flavored as desired using flavoring ingredients that are known in the art. For example, vanilla or cocoa may be added to the syrup product to produce vanilla or chocolate flavored non-dairy frozen confection. It may also be desirable to add a dairy or cream flavor to the

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syrup product so that the non-dairy frozen confection tastes more similar to ice cream.

The flavor of the syrup product may be enhanced by the addition of a small concentration of a flavor enhancer. Various flavor enhancers are known in the art and are selected based upon the particular flavoring ingredients that are used in the non-dairy frozen confection. It is also possible to enhance the flavor of the non-dairy frozen confection by adding salt in a concentration of approximately 0.35 percent by weight of the syrup product. It is believed that adding salt to the syrup product after the syrup product is formed minimizes off-flavors resulting from the addition of the salt while the syrup product is being prepared.

After the syrup product is flavored, the syrup product is frozen to produce the non-dairy frozen confection. The freezing is accomplished using processes and machines that are conventionally used to produce soft-serve or hard-pack prior art frozen confections.

The non-dairy frozen confection of the present invention surprisingly exhibits desirable functional characteristics of a frozen confection but does not require the use of exogenous sweeteners, stabilizers, emulsifiers, or proteins to produce the desirable functional characteristics. For example, the sweetness of the non-dairy frozen confection results from the glucose produced during the saccharification step.

The non-dairy frozen confection exhibits desirable viscosity characteristics without the addition of exogenous sweeteners, stabilizers, emulsifiers, or proteins. It is believed that the desirable viscosity characteristics result from the naturally occurring fiber and gums in the starch sources. In particular, the texture of the non-dairy frozen confection depends upon beta-glucan being naturally present at a level sufficient for beta-glucan to act both as a stabilizer and texturizing agent in the syrup product.

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Additionally, the non-dairy frozen confection exhibits texture and mouthfeel that are similar to ice cream, frozen yogurt, and other similar frozen confections. It is believed that the naturally occurring fat, protein, and fiber in oats result in the non-dairy frozen confection exhibiting a smooth mouthfeel characteristic. Furthermore, the syrup product does not require emulsification or homogenization to produce the smooth mouthfeel characteristic in the non-dairy frozen confection of the present invention.

A person of ordinary skill in the art would appreciate that additives, such as pectin, gums, emulsifiers such as mono- and di-glycerides, bodying agents including cyclodextrose and maltodextrins, and the like, may be added to change the texture of frozen confections made primarily from oats. However, such additives are unnecessary for the production of a satisfactory soft-serve frozen confection, and would tend to lessen the consumer appeal of a product free of additives.

A person of ordinary skill in the art would also appreciate that the syrup produced in the present invention could be used to formulate items other than frozen confections. For example, the syrup may be used to produce shakes and malts. The syrup may also be incorporated into carbohydrate-loading beverages that take advantage of the same physical and nutritional characteristics that make the syrup of the present invention useful for frozen confections.

The product and method of the present invention are described in the following examples. These examples are provided as an illustration of the invention and are not intended to limit the invention.

EXAMPLE 1

The characteristics of the non-dairy frozen confection of the present invention were studied using a blend of 70 percent by weight patent oat flour and 30 percent by weight rice flour.

A starch mixture was prepared by dry-blending 1.91 kilograms of patent oat flour with 0.82 kilograms of rice flour. Both the patent oat flour and the rice flour had a sufficiently fine granulation such that less than 10 percent of the starch mixture was retained on a 200 U.S. mesh screen.

5 The starch mixture was then mixed into 6.35 kilograms of potable tap water to form a slurry. Next, 0.36 grams of alpha-amylase enzymes (MULTIFECT H-39C) were added to the slurry.

As the slurry was being mixed, the slurry was heated to a temperature of between approximately 58°C and 60°C. At this point, the viscosity of the slurry noticeably increased. The rate of heating was then decreased to avoid scorching the slurry. Once the slurry reached a target temperature of approximately 75°C, the slurry was maintained at the target temperature for 1 hour to allow the slurry to be converted into an intermediate syrup.

15 Next, the intermediate syrup was hot filtered through a 30 U.S. mesh screen to remove unconverted portions of the slurry. The filtered intermediate syrup was then cooled to approximately 60°C.

While mixing, 8.6 grams of glucoamylase enzymes (SPEZYME GA 300) was added to the filtered intermediate syrup. The mixing was continued while the filtered intermediate syrup was maintained at approximately 60°C for 3 hours such that the syrup product was formed.

The syrup product was then cooled to approximately 10°C and 6.63 grams of salt were mixed into the syrup product. The syrup product was sweet, bland, and clean-tasting.

25 EXAMPLE 2

In a continuously stirred vessel, approximately 6 pounds of low bran oat flour were mixed with approximately 14 pounds of water and about 0.36 grams of alpha-amylase to form a slurry. The slurry was heated to

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approximately 62°C in 14 minutes. The slurry was then further heated to about 75°C in an additional 10 minutes and held at 75°C for one hour to convert the slurry into an intermediate syrup. Next, the intermediate syrup was cooled to approximately 60°C in 11 minutes, and about 8.6 grams of glucoamylase added.

5 The intermediate syrup was maintained at a temperature of 60°C for approximately 105 minutes to convert the intermediate syrup into a syrup.

The syrup was chilled and filtered through a 40 mesh screen. Next, the syrup was then filtered through a conical filter with a slotted medium having slots about 200 microns wide. The sugar content of the filtered syrup
10 was examined using a Brix analysis and found to have a refractive index corresponding to a 21 percent by weight sugar content.

A mixture was formed by combining the filtered syrup with flavoring agents at a concentration of approximately 2 percent by weight, cocoa at a concentration of approximately 2 percent, and salt at a concentration of
15 approximately 0.2 percent. Finally, the mixture was frozen in a soft-serve machine (Taylor Model 152) to produce a frozen confection. The frozen confection was sampled and determined to have desirable texture characteristics.

EXAMPLE 3

In a continuously stirred vessel, approximately 6 pounds of low
20 bran oat flour were mixed with approximately 14 pounds mineral water and about 0.36 grams of alpha-amylase to form a slurry. The slurry was heated to approximately 60°C in 18 minutes. The slurry was then further heated to about 75°C in an additional 13 minutes and held at 75°C for 65 minutes to convert the slurry into an intermediate syrup. The intermediate syrup was then cooled to
25 approximately 59°C in 11 minutes, and about 8.6 grams of glucoamylase was added. The intermediate syrup was maintained at approximately 59°C to convert the intermediate syrup to a syrup.

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The syrup was first cooled and then filtered with a conical filter having slots approximately 200 microns wide, by continuous agitation. Filtering separated a wet bran cake weighing approximately 475 grams from the filtered syrup, which weighed approximately 3000 grams. A mixture was then formed by blending the filtered syrup with flavoring agents at a concentration of approximately 2 percent by weight, cocoa at a concentration of approximately 2 percent by weight, and salt at a concentration of approximately 0.2 percent by weight. After the mixture was frozen in a soft-serve machine to produce a frozen confection, the frozen confection was found to have a desirable texture. The frozen confection was stored in a household type refrigerator for 17 days and found to have a texture similar to commercial low-fat frozen desserts after this time period.

EXAMPLE 4

A slurry was formed by dispersing approximately 560 grams of rolled oats and about 0.6 grams of alpha amylase in approximately 1300 grams of cold water. The slurry was held at room temperature for approximately 3 hours. The slurry was then heated to approximately 180°C over a period of three hours using a hot water bath to convert the slurry into an intermediate syrup. The intermediate syrup was next cooled to approximately 60°C and mixed with glucoamylase. The intermediate syrup was maintained at about 60°C for approximately one hour to convert the intermediate syrup into a syrup. After cooling to room temperature, the syrup was filtered through a conical filter with 200 micron slots. When the filtered syrup was flavored and frozen to form a frozen confection, the frozen confection had a smooth and dry texture.

EXAMPLE 5

Cold water (175 pounds), salt (0.5 pounds), alpha amylase (25 grams), and oatmeal (75 pounds) were mixed to form a slurry in a stirred jacketed vessel. The slurry was slowly heated to a temperature of approximately

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76°C over a period of approximately 7 hours to convert the slurry into an intermediate syrup. The intermediate syrup was then cooled to approximately 66°C. Next, glucoamylase was added to the intermediate syrup and the intermediate syrup was held at a temperature of at least approximately 60°C for approximately 1.5 hours to convert the intermediate syrup into a syrup. The syrup contained an unreacted starch portion that was separated from the syrup by heating the syrup in a simmering water bath for one hour and then filtering through a 200-micron filter. The filtered syrup was flavored and frozen using a soft-serve machine to form a frozen confection that exhibited a very creamy-type texture.

EXAMPLE 6

In a jacketed vessel equipped with wall-wiping agitators, approximately 75 pounds of whole oat flour and about 25 milliliters of alpha-amylase enzyme were mixed into approximately 175 pounds of water to form a slurry. The slurry was heated to a temperature of approximately 58°C over a period of one hour, and thinned slightly with about 30 pounds of water. The slurry was heated further to 83°C over approximately one hour to convert the slurry into an intermediate syrup. After cooling to approximately 64°C, the intermediate syrup was mixed with 75 milliliters of glucoamylase. Next, the intermediate syrup was held at a temperature of approximately 60°C for one hour to convert the intermediate syrup into a syrup. The syrup was then cooled to room temperature and filtered with a juice extraction machine to separate the insoluble fiber from the syrup. The filtered syrup was flavored and frozen in a soft-serve machine (Taylor Model 152) to produce a frozen confection. The frozen confection was found to have desirable texture characteristics.

EXAMPLE 7

Cold water (129 pounds), alpha-amylase enzyme (3.5 grams), and approximately 50 pounds of partially milled oats (commonly referred to as

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"quick" oats) were combined in a jacketed stirred vessel to form a slurry. The slurry was heated to a temperature of approximately 71°C over a period of about two hours. The slurry was then held at this temperature for one hour and then cooled to 66°C to convert the slurry into an intermediate syrup. Glucoamylase
5 enzyme (50 milliliters) was added to the intermediate syrup. The intermediate syrup was further cooled to approximately 60°C and maintained at this temperature for one hour to convert the intermediate syrup into a syrup. The syrup, which had a very thick consistency, was diluted with water and filtered
10 on a juice extraction machine to separate insoluble fiber from the syrup. The filtered syrup was flavored and frozen in a soft-serve machine to form a frozen confection. The frozen confection was found to have a very smooth texture and relatively low sweetness.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes
15 may be made in form and detail without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A non-dairy frozen confection comprising a syrup product that is frozen, the syrup product being formed from a base formulation having a major amount of an oat material or waxy barley hybrid flour, the non-dairy frozen confection exhibiting selected sweetness, texture, and mouthfeel characteristics while being devoid of exogenous sweeteners, stabilizers, emulsifiers, and proteins.
2. The non-dairy frozen confection of claim 1 wherein the oat material is whole oat flour, low bran oat flour, patent oat flour, rolled oats, partially milled oats, oatmeal, or combinations thereof.
3. The non-dairy frozen confection of claim 1 wherein the syrup product further comprises a minor amount of corn flour, wheat flour, rice flour, potato flour, or combinations thereof.
4. A syrup product that is suitable for use in formulating a non-dairy frozen confection, the syrup product comprising a major amount of an oat material, the syrup product being sweet, bland, and clean tasting and being devoid of sweeteners, stabilizers, emulsifiers, and proteins.
5. The syrup product of claim 4 wherein the oat material is whole oat flour, low bran oat flour, patent oat flour, rolled oats, partially milled oats, oatmeal, or combinations thereof.
6. The syrup product of claim 4 wherein the syrup product further comprises corn flour, wheat flour, rice flour, barley flour, waxy barley hybrid flour, potato flour, or combinations thereof.

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7. A syrup product that is suitable for use in formulating a non-dairy frozen confection, the syrup product comprising a major amount of waxy barley hybrid flour, the syrup product being sweet, bland, and clean tasting and being devoid of sweeteners, stabilizers, emulsifiers, and proteins.

8. The syrup product of claim 7 wherein the syrup product further comprises oat flour, corn flour, wheat flour, rice flour, barley flour, potato flour, or combinations thereof.

9. A process for forming a syrup product that is suitable for use as a non-dairy frozen confection, the non-dairy frozen confection exhibiting selected sweetness, texture, and mouthfeel characteristics while being devoid of exogenous sweeteners, stabilizers, emulsifiers, and proteins, the process comprising the steps of:

blending a base formulation and water to form a slurry, the base formulation having a major amount of an oat material or waxy barley hybrid flour;

liquefying and saccharifying the slurry to produce the syrup product.

10. The process of claim 9 and further comprising the step of milling the oat material or waxy barley hybrid flour to a fine granulation so that less than 10 percent of the oat material or waxy barley hybrid flour is retained on a 200 U.S. mesh screen.

11. The process of claim 9 and further comprising the step of mixing additional starch sources into the base formulation, the starch sources comprising

corn flour, wheat flour, rice flour, barley flour, potato flour, or combinations thereof.

12. The process of claim 9 wherein the slurry is liquified to produce an intermediate syrup and then the intermediate syrup is saccharified to produce the syrup product.

13. The process of claim 12 wherein the slurry is liquified by:
mixing alpha-amylase enzymes into the slurry;
heating the slurry to a target temperature of approximately 75 C;
and
maintaining the slurry at the target temperature for approximately
1 hour to convert the slurry into the intermediate syrup.

14. The process of claim 13 and further comprising the step of filtering the intermediate syrup to remove unconverted portions of the slurry.

15. The process of claim 14 and further comprising the step of cooling the intermediate syrup to a saccharification temperature of between approximately 60 C and 65 C.

16. The process of claim 15 wherein the intermediate syrup is saccharified by:
mixing glucoamylase enzymes into the intermediate syrup; and
maintaining the intermediate syrup at the saccharification
temperature until the intermediate syrup is converted into
the syrup product.

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17. The process of claim 9 wherein the oat material is whole oat flour, low bran oat flour, patent oat flour, rolled oats, partially milled oats, oatmeal, or combinations thereof.

18. The process of claim 9 and further comprising the step of freezing the syrup product to form the non-dairy frozen confection.

19. A process for forming a non-dairy frozen confection, the non-dairy frozen confection exhibiting selected sweetness, texture, and mouthfeel characteristics while being devoid of exogenous sweeteners, stabilizers, emulsifiers, and proteins, the process comprising the steps of:

milling oat material or waxy barley hybrid flour to produce a finely granulated flour so that less than 10 percent of the finely granulated flour is retained on a 200 U.S. mesh screen;

mixing a major amount of the finely granulated flour with a minor amount of a starch source to form a base formulation, the starch source being corn flour, wheat flour, rice flour, barley flour, potato flour, or combinations thereof;

blending the base formulation with water to form a slurry;

liquefying the slurry to produce an intermediate syrup;

saccharifying the intermediate syrup to produce the syrup product;

and

freezing the syrup product to produce the non-dairy frozen confection.

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20. The process of claim 19 wherein the slurry is liquified by:
mixing alpha-amylase enzymes into the slurry;
heating the slurry to a target temperature of approximately 75 C;
and
maintaining the slurry at the target temperature for approximately
1 hour to convert the slurry into the intermediate syrup.
21. The process of claim 20 and further comprising the step of
filtering the intermediate syrup to remove unconverted portions of the slurry.
22. The process of claim 21 and further comprising the step of cooling
the intermediate syrup to a saccharification temperature of between
approximately 60°C and 65°C.
23. The process of claim 22 wherein the intermediate syrup is
saccharified by:
mixing glucoamylase enzymes into the intermediate syrup; and
maintaining the intermediate syrup at a saccharification
temperature until the intermediate syrup is converted into
the syrup product.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/14880

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A23G 9/00

US CL :426/565

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/565, 566, 567, 578, 618, 658

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: frozen confection, oat, ice cream, frozen dessert, syrup

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,954,360 A (BARNETT et al) 04 September 1990.	1-23
A	US 4,908,223 A (MURTAUGH et al) 13 March 1990.	1-23
A	US 5,407,694 A (DEVINE et al) 18 April 1995.	1-23
A	US 5,234,704 A (DEVINE et al) 10 August 1993.	1-23
A	US 4,428,967 A (GOERING et al) 31 January 1984.	1-23
A	US 4,804,545 A (GOERING et al) 14 February 1989.	1-23
A	US 5,013,561 A (GOERING et al) 07 May 1991.	1-23

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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07 DECEMBER 1996

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/14880

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,996,063 A (INGLETT) 26 February 1991.	1-23